Technical Exhibit 1: Radome Chamber Control and Analysis Software Specification

1. <u>Introduction.</u>

1.1. Fleet Readiness Center Southeast (FRCSE) indoor compact radome test chamber requires an upgrade in its positioning system control and data analysis capabilities. The chamber has the capability of operating in Compact Mode from 2GHz to 20GHz. By rotating the positioner 180°, the chamber can be run in a Far Field mode from 500MHz to 2GHz.

1.2. All systems were built and installed by Scientific Atlanta / Microwave Instrumentation Technologies (MI Tech). All software delivered by the Contractor shall be compatible with Microsoft Windows 7.

1.3. Currently, radome testing is performed using CompuQuest software running on Windows XP. The new software package shall consist of Radome Data Acquisition, Radome Data Analysis, Antenna Data Acquisition and Antenna Data Analysis capabilities. The Data Analysis packages shall include customizable plotting capabilities and automatic Pass/Fail Analysis based upon data provided in a "Limits" file.

1.4. The new software package shall have both analysis and plotting capabilities. All error codes shall be defined in the documentation.

1.5. The Contractor shall provide a computer on which the Contractor's software shall be installed and equipped with dual flat screen displays 1280 x 1024 resolution (minimum). The software shall utilize both displays to maximum advantage. In most instances, one display would be used for control functions, and the other display for plotting functions.

1.6. The Contractor shall develop, test, and install this software in accordance with the following specification. A certain amount of on-site software customization by the Contractor shall be required.

1.7. The Contractor shall provide a one (1) year warranty to include telephone and on-site support after software acceptance. All software defect remedies and software upgrades during this one (1) year period shall be included in the Contractor's overall price.

2. <u>Software Requirements.</u> The software shall include a Manual Plotting Software, Real Time Analysis (for semi-automated testing), Automated Data Acquisition Software, Antenna Data Analysis Software, Radome Data Analysis Software, and Batch Programming. The Contractor shall be able to provide drivers to communicate with and control equipment manufactured by the major manufacturers of typical antenna range instrumentation.

2.1. <u>Real Time Analysis / Semi-Automatic Testing.</u>

2.1.1. The software shall have the following functions available on easily accessible pop-up menus and by batch mode instructions:

a. Positioner Control: This is the control of the radome motion control subsystem. The minimum functions required are:

    (1) Ability to move to angle and wait for stop with the ability to specify direction.

    (2) Ability to select any two axes and move either of those axes using manual control. While in this mode, the real-time position of the selected axes shall be displayed.

    (3) Continuous spinning for spinning linear measurements (source feed positioner).

b. Beam Peak: Digital display of the beam peak amplitude or the difference null depth.

c. Axial Ratio Calculation: The software shall have a pop-up screen which provides a real-time display of the axial ratio using a running minimum and maximum as the source spins at 120°/second.

d. Gain: AUT gain display by subtracting readings previously acquired from a Standard Gain Horn and/or stored Standard Gain Horn constants.

e. Single Axis Peak Search: The software shall be capable of seeking for the antenna boresight within user specified search limits and park the positioner at the boresight angle and (optionally) store that angle in a file for future use as a set-up parameter. Note: Multiple frequency data acquisitions may have multiple boresight angles.

f. Two Axis Peak Search: This is the same as the Single Axis Peak Search except the peak search is performed in one axis then in a second axis. Since these axes may be interrelated, the software shall repeat this process for a user specified number of iterations. After the boresight angles are located the software shall display the angle of the peak location in both axes. The software shall optionally store the Sigma (Σ) channel amplitude and the Delta (Δ) channel amplitude in a file for later use in analysis. Note: One axis may use the Σ peak search and the other axis may use minimum Δ.

2.1.2. <u>Remote Control.</u> The radome motion shall be controllable by a simple hand-held remote control device that interfaces directly to the motion control system. Safety interlocks shall be provided to ensure computer generated automatic motion is not initiated while the hand-held device is in operation.

2.2. <u>Data Acquisition Software.</u>

2.2.1. <u>Data Acquisition Package with the following capabilities.</u>

a. Rapid instrumentation set-up: When numerous acquisition files are batched together, instrument set-up is redundant and time consuming. Certain parameters in the instrument set-up are unlikely to require re-initialization between batched acquisition files. These parameters should be initialized once at the beginning of the test.

b. Data Storage Format: The acquired data shall be stored (directly or indirectly) in Microsoft Access format. The software shall have the ability to export the data in Microsoft Access format and in Microsoft Excel format. All data files shall share a common format.

c. Abort/Stop Button: During acquisition, an abort button shall be available to allow the current acquisition to be aborted. If the acquisition is part of a batch program, the batch sequence shall be aborted with the same button.

d. Capable of staging the antenna at a previously stored boresight angle. If there is a different boresight angle for each frequency for multi-frequency runs, only single frequency data acquisitions will be permitted.

2.2.2. <u>Data Acquisition Special Requirements.</u> Some antennas have an integral receiver. The software shall have the ability to read amplitude from the receiver.

2.2.3. <u>Confirmation Plots.</u> The capabilities defined in Plotting Capabilities shall be available as a confirmation plot during data acquisition. These capabilities shall include as a minimum rectangular, polar, and pixel plots. Capabilities shall include:

a. <u>Axes.</u> Each axis shall have the following options available:

(1) Amplitude:
 (a) Scale: Log (dB) or Linear (%).
 (b) User input for amplitude offset (dB or %)
 (c) Ability to normalize plot to arbitrary reference

(2) Phase: ±180° and 360° formats

(3) Angle: ±180° and 360° formats with user input for angle offset

(4) Frequency: ability to plot multiple frequencies as various distinguishable traces

(5) Receiver channels: ability to plot multiple receiver channels as various distinguishable traces

b. Pixel Plots: The data may be acquired as rectangular (example: Azimuth scan with Elevation step) or polar (example: Roll scan with Azimuth step). The software shall be capable of plotting either of these formats in rectangular or polar formats (as appropriate).

c. Plot Labels: As defined in Plotting Capabilities.

d. Plot Tool Tips: As defined in Plotting Capabilities.

e. Cursor Readouts: As defined in Plotting Capabilities.

f. Dynamic Rescale: The software shall allow the user to rescale the confirmation plot while the data is being acquired from the current time onward (no historical data dynamic rescaling).

2.2.4. <u>Radome Data Acquisition.</u>

a. Radome data is collected by taking a reference of the test antenna (AUT) without the radome present. The radome is then installed and the measurements are repeated. The reference data is subtracted from the radome response data to obtain the effects of the radome. The software shall have the ability to subtract two data sets to produce a third set for analysis and display.

b. The Compact Radome Test Range uses a gimbal mount on the AUT to scan for boresight. The gimbal mount scans in the Azimuth and Elevation directions. The boresight scan may be an iterative process, requiring two (2) iterations.

(1) When scanning is performed for the AUT Boresight, an Azimuth scan for boresight is performed and the AUT is parked at Azimuth boresight. Next, an elevation scan for boresight is performed and the AUT is parked at Elevation boresight. This may require multiple iterations.

(2) Sometimes a radome test may involve locating the AUT boresight at every test point on the surface of the radome which may be time consuming. In this type test, the radome would have two step axes, and finding the AUT boresight would involve scanning two axes.

(3) Some AUT's have separate outputs for Azimuth Δ and ElevationΔ. Therefore, the software shall have the ability to utilize two different channels on the receiver for different axes.

(4) The software shall be capable of using Σ boresight for one axis and Δ boresight for another axis.

c. Frequently, the exact AUT boresight position will change with frequency; therefore the boresight process may have to be repeated for each frequency. This is usually done by repeating the entire radome test at each frequency using an AUT boresight location which was previously measured and stored (as part of the reference data). However the multi-frequency data acquisition (using the same AUT boresight position) shall be an option.

2.3. <u>Analysis Software Requirements.</u>

2.3.1. The software shall be capable of storing and retrieving test program files and/or the antenna test data from the computer hard disk, or removable media disk.

2.3.2. The software shall be capable of subtracting the difference between two similar data sets and analyzing the difference between the data sets, or subtracting a constant offset from a data set. With respect to Transmission Efficiency (2.4.2) and Beam Deflection (2.4.4), reference file selection and subsequent data analysis shall be accomplished after all test data has been collected.

2.3.3. Since the range is also capable of performing measurements with the azimuth positioner set to 180°, the software shall have the capability of subtracting 180° from the scan angle.

2.3.4. The software shall be capable of plotting the antenna patterns in either rectangular or polar format and sending the plots to the display or printer. The requirements of section 2.2, Data Acquisition Software, shall apply in addition to the following requirements:

a. Capable of plotting at least two (2) different test data on the same figure for comparison purposes.

b. Capable of plotting a desired amplitude or phase column of data associated with a specific frequency and channel or bin.

c. Capable of automatically generating and saving plot (one or all) for each amplitude or phase data based on the user selections.

d. Capable of producing Contour Plots.

e. Capable of drawing colored lines on the display (pass/fail limits), either manually or as part of the plot definition.

f. Capable of adding text (comments) to the display.

g. Capable of user format for header and footer, including the capability to automatically insert the data filename and/or date and/or time.

2.3.5. The software shall be capable of performing the following functions and analysis, and automatically comparing these measured values to "Pass/Fail" specifications for a particular antenna type. Output shall be displayed on the computer screen with print option or sent directly to the printer.

a. The software shall be capable of locating the antenna boresight by any of the following methods (user selectable).

   (1) Maximum value of the SUM response curve.

   (2) Midpoint of the 3dB points on the scan or "X"dB points on the scan (user selected value of X).

(3) Intersection of the tangent lines to the 3dB points of the Σ curve, or “X”dB points of the Σ curve.

(4) Minimum value of the Δ response curve.

(5) Intersection of the tangent lines of the Δ curve.

b. Δ null depth below the Σ signal.

(1) Depth below the actual peak of the Σ signal.

(2) Depth below the Σ signal amplitude at the same scan position.

c. Σ Side lobe amplitude below the peak of the Σ channel for the first, second, or third side lobes. The software shall have the option to ignore vestigial side lobes. A side lobe shall be defined as the location where the first derivative of the amplitude curve changes from positive to negative.

d. Σ Side lobe location referenced to the boresight location.

e. Δ Side lobe amplitude below the Σ signal (for the 1^{st}, 2^{nd}, or 3^{rd} side lobes).

(1) Depth below the actual peak of the Σ signal.

(2) Depth below the Σ signal amplitude at the same scan position.

f. Δ Side lobe amplitude above the Δ null.

g. Δ - Σ boresight angular difference (the boresight error of the Δ signal as compared to the Σ boresight location).

h. Beamwidth (3dB beamwidth or “X”dB beamwidth, with” being user selectable).

i. Antenna Gain based on previous readings (or subsequent readings) taken from a standard gain horn (the calculation shall include gain values extracted from a gain horn calibration table).

j. Axial Ratio using spinning linear source or using a dual polarized source antenna and a transmitter switch, using a moving analysis window, within user specified angular limits (±X° of boresight) or over the entire scan.

(1) Maximum (worst case Axial Ratio)

(2) Average Axial Ratio

2.3.6. At the conclusion of a test, the software shall provide a summary of the test results, including information of Pass / Fail.

2.3.7. The software shall be capable of exporting the analysis data in Microsoft Excel format.

2.3.8. The software shall be capable of overlaying a curve (specified in Excel format with Angle and Amplitude columns), with a user-specified vertical and horizontal offset.

2.4 Radome Data Analysis. The software shall automatically analyze the radome test data and compare to Pass/Fail limits. The results shall be displayed and/or printed on a summary sheet, including the location and value of any failed data and the Pass/Fail limit used. The software shall have the option to plot the post-analysis results.

2.4.1 Definitions.

a. Dead Zones: The radome may have dead zones (areas with radar absorbent material or metal inclusions within the dome). All data acquired within the dead zones shall be ignored during data analysis. Dead zones are specified as min/max Azimuth° and min/max Roll°. The software shall have the ability to ignore data from up to five (5) user-specified dead zones.

b. Sectors: Radomes are usually divided into zones or sectors of criticality (not to be confused with dead zones). Each sector may have different pass/fail specifications depending on the criticality to the radar performance, or physical limitations caused by the design of the dome. Sectors are specified as min/max Azimuth° and min/max roll°. The software shall have the capability to accept up to six (6) different user-specified sectors.

2.4.2. Transmission Efficiency (insertion loss of the radome).

a. The reference data can be acquired in either of two ways. The analysis software shall be capable of using either of these two methods.

   (1) Variable Reference: Σ boresight is located. The software will then perform a full scan of the radome positioner without the radome present. The Σ amplitude data collected is subtracted from the radome measured Σ data (point for point) to obtain the Transmission Efficiency.

   (2) Constant Reference (single frequency): This will be the same as Full Scan except that the radome mount is not scanned. It is assumed that the position of the radome mount has no effect on the response of the AUT. Therefore the AUT response is a constant regardless of the scan angle. One reference value is used for all frequencies.

   (3) Constant Reference (multi frequency): This is the same as Constant Reference Single Frequency except a different reference value is used for each frequency.

b. Numerical Analysis:

(1) Transmission Efficiency (TE): The software shall calculate the TE, expressed in % or dB for each step or sector (excluding dead zones).

(2) Average Transmission Efficiency (ATE): The software shall calculate the ATE for the entire surface of the radome (excluding dead zones).

(3) Zone Average Transmission Efficiency (ZATE) for each sector: The software shall calculate the ZATE for all measurements within a sector (excluding measurements contained within a dead zone).

2.4.3. <u>Transmission Efficiency Rate of Change (TE Slope).</u> This is the first derivative of the Transmission Efficiency. This is specified as the maximum TE change within a sliding window (typically 12°). The software shall calculate Transmission Efficiency Rate of Change in both the scan axis and the step axis and use the worst case.

2.4.4. <u>Boresight (Beam Deflection).</u> The radome boresight data may be acquired and analyzed in two different methods. Each method requires a different reference data collection.

a. Gimbal Scan Method: This is the easiest to understand. The software shall perform a one or two axis peak search of the AUT, record the position of the AUT boresight, then step the radome to the next test position. This would involve two step axes for the radome position. The concept of how the test is performed is as follows:

(1) Before the radome is mounted, locate Boresight and record this position as the AUT Reference Boresight position (in Azimuth° and Elevation°).

(2) After the radome is mounted, at each radome data point the motion of the radome is stopped and once again the software shall perform the one or two axis peak search. This position is then subtracted from the AUT Reference Boresight position to get the boresight error (in Azimuth° and Elevation°). The total Boresight Error (Squint Angle) is calculated using the Pythagorean formula. The Pass/Fail criteria for this test may involve Azimuth° and Elevation° or total Boresight Error°.

b. Null Analysis Method:

(1) Before the radome is mounted, the technician locates the AUT Reference Boresight using the Δ channel and a one or two axis peak search. The technician records this position and the corresponding Null depth as the AUT Reference Boresight position.

(2) Before the radome is mounted, the technician characterizes the AUT Null as follows: The technician adds the Maximum Allowable Boresight Error to the AUT Reference Boresight Position and reads the corresponding Δ channel null depth. The technician then subtracts the Maximum Allowable Boresight Error to the AUT Reference Boresight Position and reads the corresponding Δ channel null depth. Using this characterization, the Δ null depth (Maximum Boresight Δ Amplitude), which corresponds to the specified Maximum Boresight Error°, can be determined.

(3) After the radome is mounted, the AUT is parked at the AUT Reference Boresight position. The software shall scan the radome without moving the AUT and record the Δ channel amplitude corresponding to all measurement points on the surface of the radome. This amplitude is compared to the Maximum Boresight Δ Amplitude to determine Pass/Fail. Since Null Degradation will affect the accuracy of this measurement (and may cause a false fail), further analysis may be required.

(4) The technician locates the worst case failure from the previous step (this represents the maximum deviation away from boresight). The technician then positions the radome to that location and performs a one or two axis peak search using the Gimbal Scan Analysis to determine the actual boresight error.

2.4.5. Null Depth. If this analysis is performed, the data must be collected using the Gimbal Scan Boresight method. The depth of the Δ channel null is compared with the Σ channel to determine the minimum Null Depth.

2.4.6. Null Degradation. The measurement is identical to Null Depth, except the depth of the Δ channel null with the radome is subtracted from the same measurement without the radome to determine the Null Degradation.

2.4.7. Boresight Rate Of Change (Boresight Slope). This is the first derivative ($^{d\theta}/_{dt}$) of the squint angle. This analysis can only be performed with the Gimbal Scan method of measuring the Boresight Error. This is specified as the maximum Boresight Error° change within a sliding window (typically 12°). The software shall calculate $^{d\theta}/_{dt}$ change in both the scan axis and the step axis and use the worst case.

2.4.8. Maximum Rate Of Change Of Phase (Phase Slope). This is the first derivative ($^{d\phi}/_{dt}$) of the AUT phase. The software shall calculate phase change in both the scan axis and the step axis and use the worst case. This is specified as the maximum number of degrees of phase shift within a sliding window (typically 12°).

2.4.9. Depolarization.

a. Reference data (without the radome) is collected by scanning the source polarization to locate the maximum Σ channel amplitude.

b. Radome data is collected by performing the identical scan of the source polarization with the radome present. The reference polarization angle is subtracted from the radome polarization to calculate the polarization difference (or depolarization). The result is usually expressed in degrees.

2.4.10. Axial Ratio Degradation. This measurement is closely related to Depolarization, except the Axial Ratio of the reference data is subtracted from the Axial Ratio of the radome data. The result is usually expressed in percent.

2.4.11. Pattern Distortion.

a. Reference data (without the radome) is collected by scanning the AUT and the radome mount simultaneously in the Azimuth direction, far enough to capture the first several sidelobes. This is made possible because the AUT mounting post can be mechanically locked to the Radome Mount, so both scan together when the radome Azimuth axis is moved.

b. Radome data is collected by performing the identical scan of the AUT with the radome present. The reference data is subtracted from the radome data (point for point) and the difference (amplitude) to obtain the pattern degradation.

c. Using this data the following analysis can be performed:

(1) Beamwidth Degradation: Using the same data as the Pattern Distortion measurement the beamwidth of the reference data is subtracted from the beamwidth of the radome data. The user shall have to option to evaluate the 3dB beamwidth or an arbitrary beamwidth. The result is expressed in % or degrees of the reference data beamwidth.

(2) Sidelobe Degradation: Locate the first and second sidelobes on the AUT reference data and compute the sidelobe degradation (in dB).

(3) Root Mean Square (RMS) Pattern Degradation: Using a sliding 12° window, and ½° steps, calculate the RMS pattern for both the “with radome” and “without radome” case using the following formula. Then subtract the RMS pattern “with radome” from the RMS pattern “without radome” to compute the RMS pattern degradation.

$$10\log\left(\frac{\sum_{n}^{n+m} Log^{-1}\left(Pm/10\right)}{m+1}\right)(dB)$$

w is the width of the sliding window (typically 12°)

s° is the step width within the sliding (typically ½°)

m = w * s
n = window start angle integer index

2.4.12. Reflection/Voltage Standing Wave Ratio (VSWR). VSWR should be measured without the radome present and again with the radome. The VSWR degradation can be calculated by subtracting the measurements.

2.5. Plotting Capabilities. The software shall have plotting options that include Rectangular, Polar, Contour, Pixel, or Isometric. Each plot type shall have at least three (3) axes available:

2.5.1. Axes. Each axis shall have the following options available:

a. Amplitude:

(1) Scale: Log (dB) or Linear (%)

(2) User input for amplitude offset (dB or %)

(3) Ability to normalize dependent variable to arbitrary reference

(4) Ability to subtract a calibration file

b. Phase: ±180° and 360° formats with the Ability to subtract a calibration file.

c. Scan Angle: ±180° and 360° formats with user input for angle offset.
d. Step Angle: ±180° and 360° formats with user input for angle offset.

e. Frequency: ability to define which frequency(s) shall be plotted. Optional display of actual frequency or frequency code number "$F_{1,}$ $F_{2,}$ ..F_n" in plot key.

f. Receiver Channels: ability to define which channel(s) from the receiver shall be plotted.

2.5.2. Pixel Plots. The third dimension (usually Amplitude or Phase Angle) is plotted as a pixel in a graduated color.

a. The color scale style (RGB, Gray Scale, Green/Yellow) shall be chosen from a plot menu bar.

b. The data may be acquired as rectangular (example: Azimuth scan with Elevation step) or polar (example: Roll scan with Azimuth step). The software shall be capable of plotting either of these formats in rectangular or polar formats (as appropriate).

c. Interpolation: The software shall have the capability to interpolate values between measured values, thus eliminating some of the harshness of the pixel plot.

d. Image Cuts: Image cuts shall be available for Pixel Plots. These shall be represented as an X-Y plot in the left and bottom margin of the pixel plot.

2.5.3. Contour Plots. Contour plots are similar to pixel plots except contour lines are drawn instead of pixels. The software shall provide the following options:

a. Dynamic range divided up equally (in %) by the number of Contour Cuts requested.

b. Dynamic range divided up equally (in dB) by the number of Contour Cuts requested.

2.5.4. Overplot. The software shall have the ability to overlay multiple plots on the same display.

2.5.5. Plot Display Parameters.

a. Scale: User selectable scales or autoscale option for each axis.

b. Plot Background: User can choose between black or white backgrounds for the data area of the plot window. The data area on the plot window is the "gridded" window where the plot is actually drawn.

c. Window Color: User can choose between gray or white backgrounds for the non-data area of the plot window. These are the areas inside the plot window but outside of the grid.

d. Grid Lines: User may select grid lines on, grid lines off, grid line color, 8/6/4 Line Color and grid line thickness.

e. Plot Size: The user may choose 25% 50%, 75% or 100% of screen height for initial plot size. Plots can always be resized with the mouse after processing.

2.5.6. Plot Labels. There shall be seven (7) label fields defined for plots. The labels are:

a. "Classify": Centered at top of plot window in bold red text. Options: "Secret" (within a red banner), "Confidential" (within a yellow banner), "Unclassified" (no banner).

b. Date and Time: Right justified on the Classify line.

c. Plot Title: Bold text, centered at top of plot (1^{st} line below Classify).

d. Serial # and Run #: Left justified on the Title line.

(1) The Serial Number and Run # shall be stored in the header of the Acquisition File.

(2) The Serial Number is an eight (8) digit (max) alphanumeric character string.

(3) The Run # is a single alphanumeric character which is separated from the Serial # by one blank space.

(4) When using the batch language, the Serial # & Run # shall be acquired from the batch variables.

e. Data File Name: Right justified on the Title line.

f. Label 1: Left justified below Title line (at the top of the plot).

g. Label 2: Left justified at bottom of plot.

2.5.7. <u>Plot Key.</u> A key block or key line shall be provided below or to the side of the plot providing pertinent data about the data acquisition and the plot parameters. The data necessary in the key varies depending on the type of plot, and the axes selected.

2.5.8. <u>Print.</u> To print a copy of the plot, the user may select the following options:

a. Best Fit scales of the height and width dimensions of the plot to the dimensions of the printed page while retaining the aspect ratio of the plot.

b. Stretch to Page rescales to the dimensions to the printed page without regard to the plots aspect ratio.

c. The Scale 80/60% determines the size of the plot relative to the full page while retaining the aspect ratio.

d. The Whole Screen option prints out a capture of the complete screen. All plots are centered.

2.5.9. <u>Save.</u> The software shall have the ability to save the current plot to an image file in either BMP or JPG format.

2.5.10. <u>Zoom.</u> Ability to zoom on a plot region by dragging a zoom window with the mouse. Maximum resolution available in the data file shall be maintained. An easy way to back-up to the previous zoom shall also be provided.

2.5.11. <u>Plot Tooltips.</u> When selected, this gives the readout of the data at the mouse cursor location on the in a “tooltip balloon” which follows the cursor as it moves.

2.5.12. <u>Regenerate.</u> The ability to regenerate the plot after parameters has been changed.

2.5.13. <u>Cursor Readouts.</u>

a. 2D Line Plots: After a 2D Line Plot has been completed, if the operator moves the cursor (with the mouse) onto the plot grid, a display of the (X,Y) value pair for the plot at that location is displayed on the Title Bar of the plot window.

b. 3D Pixel Plots: After a 3D Pixel Plot has been completed, if the operator moves the cursor (with the mouse) onto the plot grid, a display of the (X,Y,Z) value pair for the plot at that location is displayed on the Title Bar of the plot window. This is a true readout of the pixel on which the cursor is sitting.

2.5.14. Overlay File (X-Y Plots only).

a. The overlay files which are used by the image processing display software to aid the operator in identifying particular important levels on the graph. Usually this will be used to overlay pass/fail criteria on the graph such as horizontal lines, vertical lines or a cosecant squared (CSC^2) curve. The line or shape defined in the overlay file shall be overlaid on the plot similar to the overplot function. The overlay file shall be in the form of an ASCII text file. Overlay commands shall be as follows:

(1) TRACE,z: Selects which trace the following commands are applicable to (useful for "Min" and "Max" functions).

(2) SCALE,x: Scale each MOVE and DRAW parameter by this amount (x). This is a multiplicative scaling.

(3) ORIGIN,x,y: This identifies in (X,Y) space where on the overlay the origin should be. All locations (x and y) are referenced to this origin (-x meaning to the left of the origin, etc.). If the negative sign is omitted, the value is assumed to be positive. These coordinates are SCALE'd.

(4) Special Cases:

(a) If the letters "Max" are substituted for the value of x or y, this means the maximum (or beam peak) location shall be substituted for that coordinate. For example: ORIGIN,x,Max means the y value of the beam peak shall be substituted for the y value of the ORIGIN command. Likewise ORIGIN,Max,Max would mean the origin would be the x and y coordinates of the actual beam peak.

(b) If the letters "Min" are substituted for the value of x or y, this means the Minimum value of the curve shall be substituted for that coordinate.

(c) MOVE,x,y: This instructs the overlay drawing software to move to the specified coordinate.

(d) DRAW,x,y: This instructs the overlay drawing software to draw a line from the current (X,Y) coordinate to this new (X,Y) coordinate.

(e) POINT,x,y,r: This places a dot or a circle of radius "r" at the x,y coordinates.

b. Comments can be added to any line preceded by the "!" symbol.

c. Once the overlay file has been placed on the plot, the software shall allow the overlay to be moved Up, Down, Left or Right (equivalent to moving the "ORIGIN").

2.6. Utility Programs. The software shall provide the following utilities:

a. Frequency Merge: Limitations of the frequency source, or the source feed horns prevent all the frequencies to be collected in one scan. After the data is collected, the software shall be capable of merging the data from the same type acquisition (performed at multiple frequencies) into a single file as if the data were collected from a single multi-frequency scan.

b. Acquisition File Scan Merge: The software shall have the ability to merge two partially collected scan data into one file. Sometimes mechanical limitations of the positioner prevent data for the entire test to be collected in one scan. If this involves inverting the AUT, it may be necessary to complement the scan and step angles. Generally, the software shall be capable of merging multiple data files and shall store data in a format conducive to this requirement.

c. Export Data File: A program allowing an Acquisition Data File to be exported to Microsoft Excel Format and / or a text file.

2.7. Batch Programming. A batch programming capability shall be available to permit multiple data acquisitions, analysis(s) and plot(s) to be combined into one test sequence. As a minimum the batch programming shall have available the following commands:

a. Display message to user and require confirmation before proceeding.

b. Display message to user with no confirmation required to proceed.

c. Ability to ask the user to input a numeric or string variable and use it as part of the analysis labels, plot labels, or concatenated with other characters to form data filenames.

d. Single Axis Peak Search and save the location as a variable.

e. Two Axis Peak Search and save the location as 2 variables (Azimuth & Elevation).

f. Move a selected axis to a selected position in a selected direction. This position can be specified as part of the command or as a variable to be obtained from the variable generated by the Single Axis Peak Search or Two Axis Peak Search.

g. Return all instruments to local control mode.

h. Set the signal source output power to OFF.

i. Set the signal source to a certain frequency.

j. Initialize a specified instrument with default parameters.

2.8. <u>User Interface.</u> Tabs shall be used to organize the software into functional groups. Most of the tests will be organized into a batch program. Tabs shall be included for:

a. Batch programs available and allow execution of the programs by double-clicking on the program.

b. Semi-Automated Testing (including strip-chart mode).

c. Control (including Troubleshooting & Instrument set-up).

d. Test Summary.

e. Data Acquisition.

f. Data Analysis.

g. Plotting.

2.9. <u>Security Requirements.</u>

a. Some of the antennae tested have classified frequencies or classified specifications. Therefore all printed/plotted data shall have the option to specify the frequencies as actual numbers or frequency codes (F1, F2, etc.).

b. All printed/plotted data shall have the option to place the header "SECRET" or "CONFIDENTIAL" or "UNCLASSIFIED" with a check box.

c. Data storage, Acquisition Files, and Analysis Files will normally be stored on a CDR disk using a U.D.F. Packet Format to make the CDR behave like a removable media hard disk (Government provided packet format drivers). The actual operating system and the software provided by the Contractor shall not be classified and shall be stored on the computer's hard disk. However, acquisition definition files, analysis definition files, plot definition files, and acquired data shall be stored on the CDR disk. The software shall have the ability to write data to this drive and the computer shall have the necessary hardware to accommodate this requirement.

Technical Exhibit 2: Radome Performance Acceptance Test

1. F-18 C/D Radome:

Table 1: F-18 C/D Radome Performance Acceptance Test Outline

Test Parameter	**Test Antenna**	**Freqs & Polarization**	**Antenna Orientation**	**Scan Plane & Limits**
Power Transmission (one way): - Minimum - Average	APG-65	F0 Pol = Vertical	0º, 45º, 75º and 90º ant/radome rolls	Radial: ±65º
Antenna Beam Deflection: - Beam Deflection - BD Rate of Change	APG-65	F0 Pol = Vertical	0º, 45º, 75º and 90º ant/radome rolls	Radial: ±65º
Antenna Pattern distortion: - Main Lobe BW - Sidelobe Intensity - Peak Sidelobes outside ± 15º of antenna Beam Peak - RMS Sidelobes (12º scan interval) - Reflection Lobe	APG-65	F0-100 Pol = Vertical F0+100 Pol = Vertical	Antenna offsets (in scan plane) of -30º, -40º, -50º, and -60º from 0º Az/-6º El. Antenna offsets (in scan plane) of -40º and -60º from 0º Az/-6º El.	Scan Plane through antenna beam peak Rolled +10º from H-plane; ±90ºScan Limits.
Repeatability	APG-65	F0 Pol = Vertical		
Reflected Energy	APG-65	F0 Pol = Vertical		

Technical Exhibit 3: Contract Data Requirements List (CDRL)

DIN	**Title**	**Sub-Title**	**Reference Paragraph**
A0001	Technical Documentation	N/A	SOW 4.2.1. and 5.11.3.
A0002	Training	N/A	SOW 4.2.3. and 5.11.4.
A0003	Reports	RF Probing	SOW 5.11.5.a.
A0004	Reports	Baseline Establishment	SOW 5.11.5.b.

CONTRACT DATA REQUIREMENTS LIST (1 Data Item)	Form Approved OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 110 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Services Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **Please do not return your form to the above organization. Send completed form to the Government Issuing Contracting Officer for the Contract/PR No. listed in Block E.**

A. CONTRACT LINE ITEM NO.	B. EXHIBIT	C. CATEGORY:
0003	3	TDP X TM ____ OTHER ____

D. SYSTEM/ITEM	E. CONTRACT/PR NO.	F. CONTRACTOR
Antenna and Radome Range		

1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE
A0001	Technical Documentation	

4. AUTHORITY (Data Acquisition Document No.)	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	4.2.1. & 5.11.3.	Fleet Readiness Center Southeast

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
N/A	D	One time	Block 16
8. APP CODE		11. AS OF DATE	13. DATE OF SUBSEQUENT SUBMISSION
N/A			

14. DISTRIBUTION

a. ADDRESSEE	b. COPIES Draft	Final Reg	Final Repro
Technical POC		4	
15. TOTAL	0	4	0

16. REMARKS

The Contractor shall provide 3 hard-copies and 1 electronic copy each (Adobe PDF or MS office) to the Government Technical Point of Contact at least two (2) weeks prior to the training. Technical documentation includes:

a. Schematic Block Diagram
b. Operations and Maintenance Training Lesson Plans
c. System Reference Manual
d. Hardware Operator Manuals
e. Software Operator Manuals
f. Hardware Maintenance Manuals with Illustrated Parts Breakdown
g. Preventative Maintenance Manual
h. Calibration and Measurements Requirements
i. System Commercial off-the Shelf Manuals
j. System Supplemental Data for Commercial Off-the Shelf Manuals
k. Site-specific System Manual

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE
JOHNSON.RYAN.A.1385251366 Digitally signed by JOHNSON.RYAN.A.1385251366 Date: 2016.05.31 13:49:45 -04'00'	5/31/16	CATHERINES.PHILIP.W.1229574791 Digitally signed by CATHERINES.PHILIP.W.1229574791 Date: 2016.06.01 09:44:40 -04'00'	06/01/2016

CONTRACT DATA REQUIREMENTS LIST
(1 Data Item)

Form Approved
OMB No. 0704-0188

A. CONTRACT LINE ITEM NO. 0003	**B. EXHIBIT** 3	**C. CATEGORY:** TDP X TM ___ OTHER ___
D. SYSTEM/ITEM Antenna and Radome Range	**E. CONTRACT/PR NO.**	**F. CONTRACTOR**

1. DATA ITEM NO. A0002	**2. TITLE OF DATA ITEM** Training Materials	**3. SUBTITLE**
4. AUTHORITY *(Data Acquisition Document No.)*	**5. CONTRACT REFERENCE** 4.2.3. & 5.11.4.	**6. REQUIRING OFFICE** Fleet Readiness Center Southeast

7. DD 250 REQ N/A	**9. DIST STATEMENT REQUIRED** D	**10. FREQUENCY** One time	**12. DATE OF FIRST SUBMISSION** Block 16
8. APP CODE N/A		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**

16. REMARKS

The Contractor shall provide one (1) copy of all training materials, consisting of one (1) hard copy and one (1) CD, per section 4.2.3. for up to 10 Government personnel.

14. DISTRIBUTION

a. ADDRESSEE	b. COPIES Draft	Final Reg	Final Repro
Technical POC		1	
15. TOTAL	0	1	0

G. PREPARED BY JOHNSON.RYAN.A.1385251366 Digitally signed by JOHNSON.RYAN.A.1385251366 Date: 2016.05.31 13:50:40 -04'00'	**H. DATE** 5/31/16	**I. APPROVED BY** CATHERINES.PHILIP.W.1229574791 Digitally signed by CATHERINES.PHILIP.W.1229574791 Date: 2016.06.01 09:47:46 -04'00'	**J. DATE** 06/01/2016

CONTRACT DATA REQUIREMENTS LIST (1 Data Item)	*Form Approved OMB No. 0704-0188*

A. CONTRACT LINE ITEM NO.	B. EXHIBIT	C. CATEGORY:
0003	3	TDP X TM ___ OTHER ___

D. SYSTEM/ITEM	E. CONTRACT/PR NO.	F. CONTRACTOR
Antenna and Radome Range		

1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE
A0003	RF Probing Report	

4. AUTHORITY *(Data Acquisition Document No.)*	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	5.11.5.a., 5.1.15, & 5.2.13	Fleet Readiness Center Southeast

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
N/A	D	One time	Block 16
8. APP CODE		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**
N/A			

16. REMARKS

The Contractor shall provide report of probing results to the Government at contract completion (one (1) hard copy and one (1) electronic copy in PDF format).

14. DISTRIBUTION

a. ADDRESSEE	b. COPIES Draft	Final Reg	Final Repro
Technical POC		2	
15. TOTAL →	0	2	0

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE
JOHNSON.RYAN.A.1385251366 Digitally signed by JOHNSON.RYAN.A.1385251366 Date: 2016.05.31 13:51:08 -04'00'	5/31/16	CATHERINES.PHILIP.W.1229574791 Digitally signed by CATHERINES.PHILIP.W.1229574791 Date: 2016.06.01 09:43:13 -04'00'	06/01/2016

CONTRACT DATA REQUIREMENTS LIST (1 Data Item)	*Form Approved OMB No. 0704-0188*

The public reporting burden for this collection of information is estimated to average 110 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Services Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **Please do not return your form to the above organization. Send completed form to the Government Issuing Contracting Officer for the Contract/PR No. listed in Block E.**

A. CONTRACT LINE ITEM NO.	B. EXHIBIT	C. CATEGORY:
0003	3	TDP X TM ____ OTHER ____

D. SYSTEM/ITEM	E. CONTRACT/PR NO.	F. CONTRACTOR
Antenna and Radome Range		

1. DATA ITEM NO.	2. TITLE OF DATA ITEM	3. SUBTITLE
A0004	Baseline Establishment Reports	

4. AUTHORITY *(Data Acquisition Document No.)*	5. CONTRACT REFERENCE	6. REQUIRING OFFICE
	5.11.5.b. & 5.3	Fleet Readiness Center Southeast

7. DD 250 REQ	9. DIST STATEMENT REQUIRED	10. FREQUENCY	12. DATE OF FIRST SUBMISSION
N/A	D	One time	Block 16
8. APP CODE		**11. AS OF DATE**	**13. DATE OF SUBSEQUENT SUBMISSION**
N/A			

16. REMARKS

The Contractor shall submit reports of all testing of the Baseline Establishment to the Government for evaluation at least two (2) days prior to training to validate operational check-out (one (1) hard copy and one (1) electronic copy in PDF format).

14. DISTRIBUTION

a. ADDRESSEE	b. COPIES Draft	Final Reg	Final Repro
Technical POC		2	
15. TOTAL	0	2	0

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE
JOHNSON.RYAN.A.1385251366 Digitally signed by JOHNSON.RYAN.A.1385251366 Date: 2016.05.31 13:51:38 -04'00'	5/31/16	CATHERINES.PHILIP.W.1229574791 Digitally signed by CATHERINES.PHILIP.W.1229574791 Date: 2016.06.01 09:45:53 -04'00'	06/01/2016